ABSTRACT

An apparatus for the continuous processing of dairy shed waste or the like to render it substantially non-toxic and produce a liquid fertiliser and soil conditioner includes a substantially horizontal and substantially air-tight process tank (6) which can hold a predetermined quantity of waste for a predetermined period of time and at a predetermined temperature and pressure sufficient for sustained natural bacterial growth and to allow anaerobic digestion, including the production of gaseous product. Part of the gaseous product, typically methane, can be recycled into the digesting material from a regulator (14) through an injector system (11) to aid volcanic action and stimulate bacterial growth in selected segments of the tank (6) prior to a baffle provided in the tank (6).

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COMPLETE SPECIFICATION

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ORIGINAL

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Invention Title: "WASTE TREATMENT"

The following statement is a full description of this invention, including the best method of performing it known to us:-

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WASTE TREATMENT

BACKGROUND OF THE INVENTION

The present invention relates to waste treatment and more particularly, but not exclusively, to dairy shed waste treatment.

To the present time, various proposals have been put forward for the utilisation of organic waste material, whether agricultural, horticultural or human. Typically, such treatment will be addressing two objectives:

(i) Dealing with the waste as to make it environmentally acceptable; and

(ii) Converting it into something useful.

In the latter regard, organic waste has typically been converted into a fertiliser product and/or biogas, including methane.

Many previous methods have been capable of deriving methane gas produce either by batch processing or by a continuous method. However, the by-product of solids is a sludge requiring further processing for environmentally safe disposal, irrespective of the fertiliser value of the nutrients contained within the sludge. Thus in this case the gas product is achieved yet no true fertiliser is, rather only a sludge requiring disposal.

The present invention will be described particularly with regard to the processing of dairy shed waste (cow manure), but it will be appreciated by those skilled in the relevant arts that the present invention has application throughout the area of biological waste treatment.

OBJECTS OF THE INVENTION

It is, thus, an object of the present invention according to its preferred embodiments to provide an apparatus and/or system and/or process which is able to process dairy shed waste to render it substantially non-toxic and environmentally safe by transforming the raw material into liquid fertiliser, soil conditioner while harvesting biogas on a substantially continuous basis.

Further objects of this invention will become apparent from the following description.

SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided an apparatus for the continuous processing of dairy shed waste or the like to render its substantially non-toxic and produce a liquid fertiliser and soil conditioner, said apparatus including a substantially airtight substantially horizontal and cylindrical tank, wherein the ratio of the length to diameter of said tank is between 5.5:1 and 4.25:1, to receive and hold a predetermined quantity of waste for a predetermined period of time and at a predetermined temperature and pressure specific for sustained optimum bacterial growth and to support anaerobic digestion, including the production of gaseous product, the tank having inlet means to receive the waste and outlet means to enable the discharge of liquid fertiliser, soil conditioner and gaseous product, and a pressure regulation means to control the release of the gaseous product from the tank and to maintain the predetermined pressure within the tank.

Preferably, the apparatus as defined immediately above has said tank adapted to receive discrete loads of said waste and each load is retained in the tank between its receipt and discharge for a period of approximately forty days.

Preferably, the apparatus as defined immediately above has said tank having a diameter to length the ratio of between 5.25:1 and 4.25:1.

Preferably, the apparatus as defined immediately above has the tank length to diameter ratio of approximately 5:1.

According to a further aspect of the present invention, a system for the continuous processing of dairy shed waste includes an apparatus as defined in the fourth paragraph immediately above and a heating means including a sub-tank connected with the horizontal tank, and wherein the pressure regulating means includes a gaseous product collection and harvesting means.

According to a further aspect of the present invention, a gas regulator system is adapted to control and harvest a combustible gas generated by a dairy shed waste treatment apparatus or system, said gas control system including flow control means and pressure transfer control means, said system enabling mixing of the waste material by bio-airation and wherein the pressure and fluid control of said system can be substantially maintained during its operation.

Preferably, the gas regulator control system as immediately defined above includes means to combust the combustible gas to facilitate the maintenance of temperature requirements for both biological transformation and anaerobic digestion to aid the production and harvesting of further combustible gas to substantially make the fertiliser and gas production system substantially self supporting.

Preferably, the gas regulator system as defined above includes process logic control means to monitor system maintenance and control.

Further aspects of this invention which should be considered in all its novel aspects will become apparent from the following description given by way of example of possible embodiments thereof and in which reference is made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1: shows diagrammatically a side perspective view of an apparatus according to one possible embodiment of the invention;

FIGURE 2: shows diagrammatically an end view of the apparatus of Figure 1; and

FIGURE 3: shows diagrammatically a dairy shed waste processing system according to one possible embodiment of the invention.

BRIEF DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention can be manufactured by any suitable technique and from any suitable materials, although principally steel, stainless steel and fibreglass may be usefully used.

Referring firstly to Figures 1 and 2, an apparatus for processing dairy shed waste to render it non-toxic and produce a liquid fertiliser and soil conditioner, as well as gaseous product (BIOGAS) is referenced generally by arrow 5. The apparatus 5 enables this processing to be effected continuously from the dairy shed waste. The apparatus 5 is preferably included within a total system which is shown very diagrammatically in Figure 3 and has a series of integrated features which will be described in greater detail later. That total system of Figure 3 allows the continuous processing of the dairy shed waste and the production of the required by-products.

As shown in Figures 1 and 2, the apparatus 5 comprises a substantially horizontal process tank 6 with a specific length to diameter ratio which defines an airtight environment 7 within it. The dome end tank 6 has an inlet 8 whereby the shed waste is able to be transferred into the environment 7 within the tank 6. The tank 6 further has an outlet 9 whereby after bacterial transformation and anaerobic digestion, the liquid fertiliser is extracted from the environment 7. Preferably, the outlet 9 may be horizontally and vertically spaced from the inlet 8 so as not to be aligned with it and be at opposite ends.

Once the shed waste has been fed into the environment 7, it must be retained there for a required length of time sufficient to enable the biological transformation and anaerobic digestion of the waste to be thoroughly carried out until it has processed the waste into the required by-products. The environment 7 must, therefore, have the necessary controlled conditions of temperature, atmosphere and pressure and of flow rate and retention time as well as the appropriate mixing moisture content.

As is well known to those skilled in the relevant arts, if animal waste is retained in an air-tight environment for a period of twelve to sixty days at a temperature of from 5°C to 40°C and a moisture content of 60% to 90%, then gas production can be achieved from the waste.

The present invention is believed to be able to achieve optimum biological transformation of the waste cow manure providing non-toxic fertiliser production from dairy shed waste by functioning on a retention time period of approximately forty days and at a pressure of approximately 70kpa maximum, at a moisture content of preferably approximately 85%, at an optimum temperature of approximately 37°C and coupled with a prescribed dimension to volume ratio integrated into the design of the tank (this is the length to diameter ratio previously mentioned). The tank 6 preferably also has one or more baffles 22 strategically placed along its length and an injector mixing and gas harvesting system 11 to provide more optimum performance.

The apparatus 5 has been designed to maintain an optimum environment within the tank 6 while being supplied with waste material on a regular daily basis and harvesting gas continually and fertiliser daily.

The volume of the environment 7 within the tank 6 may preferably be determined by the expression: V = daily load x 40 + 7%, (max.-min. 10% to 5%).

For any given application, the daily load and unload may be assumed to be substantially constant and the additional 7% can allow for space above the waste within the environment 7 for the gaseous products to collect and be transferred to the collector 17.

After the initial setting up period, each day as a quantum of waste is mixed with water to attain the desired moisture contact and is then fed in through the inlet 8, as shown in Figure 1, each quantum within the environment 7 is thereby displaced by an increment along the tank 6 and the quantum which has been in the tank 6 for the longest time is preferably taken simultaneously from the outlet 21 at the opposite end of the tank 6, without violating any of the environmental conditions required to maintain the transformation process.

With the controlled environmental conditions for biological transformation within the environment 7 including the use of the injector mixing and harvesting system 11 and baffle system 22 and with the inlet 8 and the outlet 9 preferably being at opposite ends of the tank 6 and with the tank ratio and retention time, the waste nearest the outlet 9 will be of a biologically transferred state which has passed its optimum gas generating condition and is now in a non-toxic condition meaning the pathogenic bacteria have been killed and may be now withdrawn from the tank 6 as fertiliser and/or soil conditioner.

As each quantum of waste within the environment 7 has been in the tank for a distinct and different length of time, a quality gradient is created in the waste, namely at the end nearest the inlet 8 the waste has commenced biological transformation but has not commenced anaerobic digestion and is thus giving off no gas whereas nearer the centre of the environment 7, anaerobic digestion is strong and gas production is highest and at the end nearest outlet 9, anaerobic digestion has passed its peak and thus is not giving off any significant amount of gas and will without agitation naturally collect on the outlet side of baffle 22 in the form of fertiliser and soil conditioner.

The tank 6 is dimensionally adjusted, in particular, its length to diameter is preferably within the range 4.25:1 and 5.5:1 and preferably of the order of 5:1 and this has been found in tests to ensure that the gradient is maintained along the length of the tank 6 for the continuity of the process to be maintained.

Additionally, the injector system 11 provides that gas may be recycled into the digesting material from the regulator 14 (see Figure 3) to aid volcanic action and stimulate bacteria growth in selected segments of the tank 6 prior to the baffle 22.

Additionally, the pH rating of the bacteria may be monitored through port 12. The provision of the port 12 can be of considerable significance during "start up" procedures when additional overseeing will be required to ensure that the process stabilises and continues in the proper manner.

Referring now more particularly to Figure 2, a sub-tank 20 is shown cradling the tank 6. This sub-tank 20 preferably holds water which may be heated by a gas burner inserted in tube 10 and passed through the sub-tank 20 in a closed circuit. This will provide the necessary temperature control for optimum bacteria growth. Temperature control as well as other environmental and functional controls can be maintained by the PLC system 4 (see figure 4).

Also, shown in Figure 2 are the fertiliser and soil conditioner outlets 9. A level indicator or sight glass 13 is also shown. There are also ports 15 provided for inspection and cleaning of the tank 6 during shut-down.

Gas emanating from the digesting waste will collect above its surface and can pass out through a collector 17 provided on the upper portion of the tank 6. A pressure release valve 18 is also shown provided in association with the collector 17. Insulation, (not shown), may be provided around the outer surface of the tank 6 and sub-tank 20.

As shown in Figure 3, the apparatus of Figures 1 and 2 may preferably be incorporated in a larger integrated system which can ensure the continuous production of fertiliser and soil conditioner and gaseous products and allow the gas produced to be recycled for heating and mixing in a continuous process to ensure the production of further gas and fertiliser.

Referring to Figure 3, the gas from collector 17 is shown being directed to gas regulator 14 through valve 30. Part of the gas from the gas regulator 14 can be cycled back into the environment 7 in the process tank 6 through a closed circuit injection manifold 11 to provide any necessary aid to agitation of the waste in the tank 6. This agitation can ensure the continuous production of further gas and aid the complete transformation and/or production of fertiliser and soil conditioner in the process tank 6. The bulk of the gas produced, however, is passed to the gas storage unit 25 and a portion of the gas can be lead to a gas fired burner 23 to provide the heat requirements for the system, surplus gas being diverted for alternative energy requirements indicated at 26.

Water heated in the sub-tank 20 can provide controlled temperature conditions within environment 7 in the tank 6 or may be diverted as a by-product for alternative water requirements as indicated at 27. A shed waste collector 29 is suitably provided or may be constructed as a standard shed fixture. The waste collector 29 will preferably provide for an initial mixing of the waste with water to provide an initial water content.

On the outlet 9 side of the tank 6, by-product tanks 28 can be provided to receive the products which will subsequently be used for fertiliser and soil conditioner.

It is envisaged that the by-product storage vessels 28 can be portable and not necessarily be integral fixed parts of the entire system.

It will thus be appreciated that the present invention provides a simple yet effective substantially horizontal system and apparatus and process for continually processing dairy shed waste to produce non-toxic liquid fertiliser and soil conditioner and gas for energy and, in an integrated system, can further provide the recycling of the biogas as a non-combusted air medium and use the energy derived therefrom to facilitate the further production of the fertiliser and gas from the naturally available dairy waste.

The term "dairy shed waste" is used throughout this specification for simplicity but it will be appreciated that the term covers any equivalent type of biological animal waste.

Where in the foregoing description, reference has been made to specific components or integers of the invention having known equivalents then such equivalents are herein incorporated as if individually set forth.

Although this invention has been described by way of example and with reference to possible embodiments thereof, it is to be understood that modifications or improvements may be made thereto without departing from the scope of the invention, as defined in the appended claims.

WHAT WE CLAIM IS:

1. Apparatus for the continuous processing of dairy shed waste to render it substantially non-toxic and produce a liquid fertiliser and soil conditioner, said apparatus including a substantially airtight substantially horizontal and cylindrical tank, wherein the ratio of the length to diameter of said tank is between 5.5:1 and 4.25:1, to receive and hold a predetermined quantity of waste, said waste undergoing a biological transformation, for a predetermined period of time and at a predetermined temperature and pressure specific for sustained optimum bacterial growth and to support anaerobic digestion, including the production of gaseous product, the tank having inlet means to receive the waste and outlet means to enable the discharge of liquid fertiliser, soil conditioner and gaseous product, and a pressure regulation means to control the release of the gaseous product from the tank and to maintain the predetermined pressure within the tank.

2. A system for the continuous processing of dairy shed waste, including an apparatus as claimed in Claim 1, a heating means to provide the predetermined temperature, the heating means including a sub-tank connected with the horizontal tank, and wherein the pressure regulating means includes a gaseous product collection and harvesting means.

3. An apparatus as claimed in Claim 1, which receives discrete loads of said waste and each said load is retained in the tank between its receipt and discharge for a period of approximately forty days.

4. An apparatus as claimed in either of the preceding Claims 1 and 3, wherein said ratio is between 5.25:1 and 4.25:1.

5. An apparatus as claimed in any one of the preceding Claims 1 and 3 and 4, wherein said outlet means and said inlet means are not aligned with one another longitudinally on the tank.

6. An apparatus substantially as herein described with reference to the accompanying drawings.

7. A system for continuously producing fertiliser, soil conditioner and gaseous products from dairy shed waste incorporating an apparatus as claimed in any one of Claims 3 to 6.

8. A system as claimed in Claim 2 or Claim 7, wherein a proportion of the gaseous product is fed back into the waste being processed to pressurise and agitate it and harvest gas from said waste at an appropriate place along said tank and at an appropriate stage of the biological transformation while maintaining the predetermined system parameters.

9. A system as claimed in Claim 8 when dependent on Claim 2, wherein a proportion of said gaseous product is combusted in providing heating by means of the sub-tank for the waste undergoing said biological transformation.

10. A system as claimed in any one of Claims 2 and 7 to 9 in which the pressure in said tank is no more than 70kpa.

11. A system as claimed in Claim 10, wherein the temperature in said tank is approximately 37°C.

12. A system substantially as herein described with reference to the accompanying drawings.

DATED this 26th Day of June 2002

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Fellow Institute of Patent and Trade Mark Attorneys of Australia
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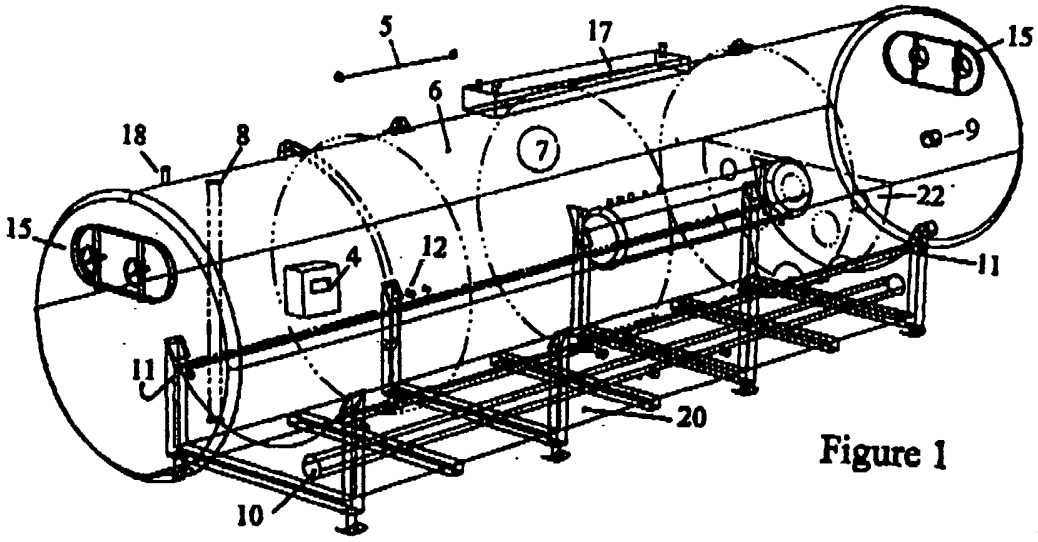

Figure 1

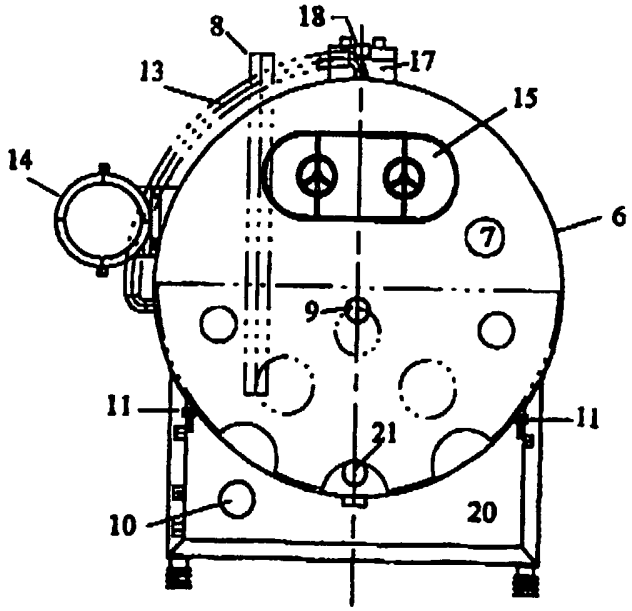

Figure 2

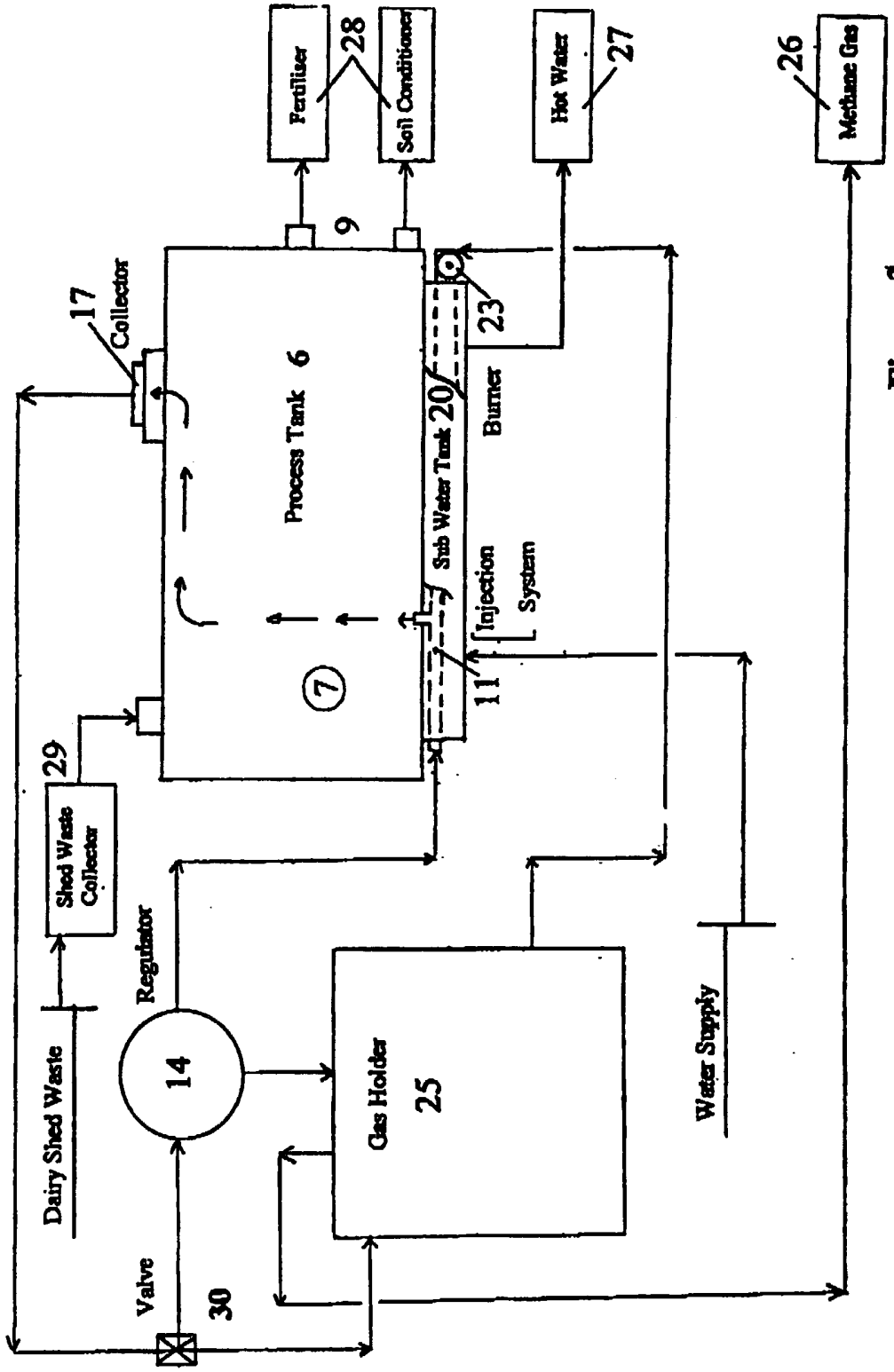
Fertiliser
28
Soil Conditioner
Hot Water
27
26
Methane Gas
9
17
Collector
Process Tank 6
Sub Water Tank 20
23
Burner
Injection System
11
7
29
Shed Waste Collector
Regulator
14
Gas Holder
25
Water Supply
Dairy Shed Waste
Valve
30

Figure 3